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# INVENTORY AND ASSESSMENT OF HYDROCARBON POTENTIAL FOR SOME MEMBER STATES OF THE EAST AND SOUTHERN AFRICAN SUBREGION AND CENTRAL AFRICAN SUBREGION

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# I. INTRODUCTION

1. It is evident that oil and natural gas will remain the basic components of the energy mix in the majority of African countries till the end of this century. Hence an attempt to explore for domestic hydrocarbon reserves in some member States of the East and South African Subregion and Central African Subregion is explained by the need for self-sufficiency in energy production.

2. Although there was always some exploration going on in most African countries even during the years of low oil prices, interest was greately spurred on after oil prices began to rise in the seventies, under the pressure of sustained rates of high growth in Africa's demand for energy that increased wide surge in exploration and development.

3. This publication gives an overview of petroleum geology and hydrocarbon potential of some member States of the East and South African Subregion and Central African Subregion. The aim of the publication is to show the state of the art in petroleum exploration in each subregion and to try to define a strategy and a plan for the development and utilization of hydrocarbon resources in this subregion.

4. The publication is based on the desk study carried out in the secretariat of the United Nations Economic Commission for Africa and on the data collected during the missions undertaken by ECA Staff in 1984-85 to Tanzania, Zambia, Mozambique and Congo. The emphasis is laid on exploration programmes for hydrocarbons undertaken by the respective Governments.

5. In each subregion four countries have been selected for this study. Among those are non-producers such as all four countries in East Africa (Ethiopia, Somalia, Kenya and Uganda), Tanzania, Zambia and Mozambique in South Africa and Rwanda in Central Africa. There are also case studies of minor oil exporters like Angola in South Africa and Cameroon and Congo in Central Africa. One of the countries (Zaire) is oil-importing medium producer of petroleum.

6. Oil and natural gas exploration and development are capital-intensive activities which require expertise not currently available to most African countries. Hence as a responce to the need of exploration efforts, the Government of the countries in East, South and Central African subregions in co-operation with UNDP, World Bank and bilateral donors have designed and implemented a number of exploration projects. The rationale for these projects was to help African countries to design an exploration strategy and systematically scan the international market in order to attract exploration capital from oil companies at reasonable terms.

7. There is a growing awareness on the part of African oil producing countries, multinational oil companies and financial institutions that existing oil and gas reserves must be developed and the discovery of potential new reserves must also go ahead. There has been a welcome move towards greater realism on all sides borne of the common understanding that despite the current lull in oil market, hard work needs to be done in Africa to secure hydrocarbon resources over the long term. It is in the interest of African member States to encourage petroleum

exploration, given the projected climb in their consumption - perhaps a doubling by the year 2000 - as they move further along the path of economic development (with population growth, increasing urbanization and, in many subsaharan countries, diminishing supplies of traditional or non-commercial sources of energy). It is in the interest of the Africa's economy as whole to provide an adequate supply of energy.

8. In this publication, an attempt was made to present general inventory and assessment of hydrocarbon potential for some member States at the various stage of the development of hydrocarbon's resource. The assessment is given in this paper is derived primarily from regional geological considerations, and, as in any dynamic process are subject to considerable change with time and application of new geologic data and techniques.

## II. PETROLEUM GEOLOGY AND ASSESSMENT OF HYDROCARBON POTENTIAL

### (a) East Africa

9. The East African sedimentary basin as a whole covers about 2 million sq. km half of which is located offshore. There is a sedimentary accumulation of great thickness registered in two places in this basin. That is in the Lower Tana River basin including the adjacent territory of Somalia (upto 9,000 m) and in another area along the axis of the trough down south. The exploratory effort spent in the East African basin includes about 120 wells which have been drilled over the past years with moderate results.

### (i) Ethiopia

10. The exploration programmes for hydrocarbons in Ethiopia were concentrated in two areas that is in the Red sea basin and in the Ogaden basin. So far one gas field of commercial value has been discovered. In the Calub field Permian-Triassic sediments are gas-bearing and a gas pool is located at the depth around 3,600 m. Oil and gas showings have also been reported from the covering Cretaceous deposits. This field is considered of medium size and it contains between 5 and 50 billion of natural gas. An extensive exploratory programme is now underway in the Ogaden basin and recently a discovery of another commercial gas field was reported.

11. Some portion of Ethiopia and Sudan belong to the Red sea basin, which has a total area of 370,000 sq. km and is located mostly offshore. It contains deposits of Paleogene-Neogene age up to 5,000 m thick offshore Massawa and Port Sudan. Both Sudan and Ethiopia are engaged in the exploration programmes in this basin but no commercial discovery has been made.

12. Ethiopia started exploration of the Red Sea basin in the Dahlak archipelago back in 1921 on the evidence of some oil seepages, probably located along some faulted zone. Ten shallow wells and three deep probes have been drilled before the Second World War and drilling operations were resumed in 1963 when five exploratory wells were completed. At least four of the above mentioned wells have had oil showings, one gas showing and in one well a gas blow-out happened severely damaging the well.

13. It is of interest to mention the developments in the oil exploration programme is the Red sea basin undertaken by the Sudan. They started exploration in the Red sea basin in 1958 and since then nine wells have been drilled, of which six are located in the Tokar Delta region, south of Suakin. Only three wells have tested gas and one of these was apparently non-commercial. The second was a wet gas discovery and the third was again non-commercial.

14. Based on these data and on geophysical evidence they calculated the reserves at Suakin at about 11 billion cu.m of gas and 4.0 million tons of condensate. The gas has a high heating value and no sulfur, which makes it an excellent fuel. Additional drilling here is required in order to confirm the preliminary figures of the reserves. There are two smaller structures in the area which may be worthy of drilling if Suakin structure turned out to be a commercial find after one or two additional wells drilled.

(ii) Somalia

15. The petroleum exploration programmes in Somalia have started back in 1950. At that time about 12 test wells were drilled combined with surface geophysics. As a result it was established that Somalia possesses all the requirements for being called a petroliferous province. Hydrocarbons have been generated in Triassic, Gretacesus and Tertiary rocks and the total thickness of sedimentary cover amounts to about 9,000 m. Many porous and permeable reservoirs are known both in carbonate and clastic sequences and various traps for hydrocarbons should be present in the territory.

(iii) Kenya

16. So far, Kenya did not identify reserves of oil or natural gas. However the sedimentary basins have not been properly explored and potential still exists for future discoveries. Data from exploration in Kenya and neighbouring countries indicate that oil and gas have been generated and that there are abandant source rocks and prospective reservoirs. Exploration efforts in the past have been held back because the structures are small and offshore shelf area is limited. The prospects for finding gas are higher than for oil. At present the value of gas is increasing, potential gas discoveries are less of a deterrent to exploration.

17. The Kenya Government has received some proposals for offshore exploration and many requests concerning contract possibilitees. The World Bank has approved a US$ 4 million loan to provide technical assistance in petroleum exploration promotion and for legal consultants, in order to evaluate the existing data and to attract private investment for exploration. These efforts are crucial to the long term energy prospects of the country.

(iv) Uganda

18. The most promising area in Uganda from the view point of petroleum possibilities is the Western Rift Valley, in particular Lake Albert. The rest of the country appears to be of little interest. Oil seepages along the faults in the Rift Valley have been known for a long time and their presence induced interest in exploration. About 20 shallow wells were drilled here and one deep

well to the depth of 1,200 m. Oil showings were found in one well and the deep well identified oil sand and numerous black shales. In 1956 the drilling operations were stopped, however interest in the petroleum prospects of the Lake Albert area continued.

19. The analysis of Uganda's geology and petroleum prospects revealed that the thickness of sedimentary cover could be as much as 4,000 m in the Lake Albert area, and this situation is rather favourable for petroleum generation. However, in the one deep well drilled the thickness of sediments was only 1,200 m. However this well was drilled close to the edge of the basin near the fault. In conclusion, the Western Rift Valley appears to be interesting for further exploration, and the next objective of exploration should be the determination of the thickness of the sediments in the Rift Valley.

20. Co-operation between Uganda and other countries in the subregion is an important prerequisite for further exploration work. The border between Uganda and Zaire runs through Lake Albert, and the entire Lake area has to be surveyed in order to get meaningful geological information. Similarly, co-operation with Tanzania and Kenya is required to complete surveys in the Southern portion of the Rift Valley and Lake Victoria. It is therefore encouraging to note that these four countries have recently agreed to participate in a joint air magnetic survey of these areas and to share the costs and results of this exercise.

(b) Southern Africa

21. From the geological point of view the East African basin is extended into South African territory and there is the trough from Dar-es-Salaam to Mtwara on the coast at the Tanzania-Mozambique border filled in by sedimentary sequence about 9,000 m thick.

22. Down south there is the Mozambican basin which as a whole covers 720,000 sq. km out of that about 470,000 are offshore. In the northern portion of the basin the sedimentary cover is about 7,000 m but in the central part it comes to 9,000 m. In this part of the basin, south of Beira, three commercial gas fields have been discovered on shore.

(i) Tanzania

23. Tanzania has to import roughly 700-800,000 tons of oil and 200-300,000 tons of refined products, and as a result the country suffers from heavy drain of foreign exchange. Hence the Tanzania Petroleum Corporation is very keen to explore and produce petroleum and the programme of exploration on land and off-shore has revealed the Songo Songo gas field and recently the Kimbiji discovery was made. There is an extensive drilling programme being undertaken by some foreign contractors such as Royal Dutch Shell (2 wells in 1984) and International Energy Development Corporation (2 wells in 1984-1985).

24. Activities financed by the World Bank in 1983 in gas exploration in the Songo Songo field area have resulted in gas findings to date that have far exceeded earlier expectations (about 500 billion cubic feet). Proven reserves

are now established, which could satisfy the equivalent of sixty-five to seventy five years of electricity consumption at existing levels.

(ii) Zambia

25. Zambia heavily relies on import of crude and petroleum products, hence the Geological Survey of Zambia places the emphasis on the evaluation of hydrocarbon potential of the country. Within Zambia at least seven sedimentary basins have been delineated favourable for petroleum prospection. The exploration work here has started with airborne gravity and magnetic survey and upon completion of seismic work the exploratory drilling is envisaged. From the geological view point this programme is justified and its successful implementation may bring rewarding results.

(iii) Mozambique

26. Mozambique is carring out the extensive programme of petroleum exploration both on land and offshore, and as a result some gas fields have been discovered. The Buzi field discovered in 1962 with gas at depth of 1450-1471 m in the middle of Cretaceous deposits, the Pande field discovered in 1961 with gas at depth of 1100-1600 m in Cretaceous sediments and finally the Temane field, discovered in 1957 with gas at depths of 1295-1300 m in Cretaceous deposits. The Pande field is considered a medium-sized field, whereas the other two are small-sized fields. Currently, the three fields are not exploited. For the exploration of the Mozambican basin close to 75 wells were drilled. However only 12 wells have been drilled throughout the shelf area and there has been no drilling since 1974.

27. At present two foreign companies have been granted a production sharing contract to explore Mozambique's onshore Rovuma Basin, covering about 5,000 sq. miles. The total commitment of companies, covering a maximum of 7 years, has been valued at US$ 60 million. The Rovuma basin is situated in North-Eastern Mozambique, immediately south of its border with Tanzania. Meanwhile Mozambique is seeking to boost an interest in its continental shelf, all of which is open for bidding.

(iv) Angola

28. Angola is one of the middle income minor exporters of oil in Africa. Estimated proved reserves of oil and natural gas in Angola (as per 1-1-1983) is 1635 million barrels of oil and 1470 billion cubic feet of natural gas. According to a recent evaluation by Petroconsultants (Geneva), estimated remaining recoverable reserves are put at over 1109 million barrels, 86 per cent of which is found offshore.

29. Production of oil in 1983 in Angola was between 8.7 and 9.1 million tons and production of natural gas was about 0.23 billion cubic meters. Oil accounts for 98 per cent of Angola's commercial energy production, 25 per cent of GDP, 84 per cent of its exports and 70 per cent of state revenues. Oil also forms the largest share of external investments and annual investments in petroleum now run at about US$ 550-600 million and it is expected that the level will continue to rise through the forthcoming decade.

30. In Angola since 1981 at least 15 fields have been discovered, all but two located outside Cabinda. The average size of the field is about 90 million barrels of oil, but the fields offshore are usually twice that large. Proved reserves of natural gas amount to 34 trillion cubic feet, and 67 per cent of this amount account for associated gas. They use at present only 10 per cent of the gas produced and the rest is flared.

31. Production of crude oil in Angola peaked at the end of 1983, when 200,000 b/day level was reached and in August, 1984 the output peaked 218,000 b/day. Angola is expected to remain a steedy minor producer in Africa in the future. There are plans to drill about 19 exploratory wells in 1985 and increase the number of development wells to 41 during 1986-88. Petroleum output growth will be concentrated in offshore fields and it is expected that nearly 20 per cent of crude expansion in the future will flow from new discoveries.

(c) Central Africa

(i) Rwanda

32. This country is famous for its methane production from the water in the Kivu Lake. Total reserves of gas dissolved in the water of the Kivu Lake are estimated around 57 billion cubic meters, and the share of Rwanda comes to 23 billion cubic meters. The sedimentary basin which embraces both Rwanda and Burundi has not been seriously considered before the last two years. There is a possibility thet petroleum exploration in the two countries could result in the discovery of a number of small oil and/or gas fields.

(ii) Zaire

33. Zaire is classified as oil importing medium producer, estimated proved reserves of oil and natural gas are 139 million barrels and 48 billion cubic feet respectively. There are reserves of methane gas in the Kivu Lake which are calculated at 34 billion cubic meters.

34. In 1983 oil production in Zaire reached 1.3 million tons, out of which export share came to 1.2 million tons. Preliminary data for 1984 showed a slight increase in production to 1.6 million tons.

35. In Zaire there is one refinery (Moanda) with a capacity of 1.75 million tons per year and a petroleum products pipeline connects Moanda with Kinshasa.

(iii) Cameroon

36. In the list of oil and gas producing African member States Cameroon is classified as middle income minor exporter. Cameroon's place on the oil map of Africa has largely been earned since the late seventies. From 1981 it has been a net oil exporter with over 90% of commercial energy from hydrocarbons.

37. In 1983 Cameroon produced between 5.9 and 6.2 million tons out of which 5.0 million tons have been exported. Preliminary figure of production in 1984 estimated around 8.0 million tons.

38. Petroconsultants (Geneva) estimated recoverable oil reserves of oil in Cameroon at around 530 million barrels all located offshore and that is enough for 17 years at the current production rate of 152,000 b/day. However in 1981-84 there were at least 11 new oil discoveries, and these reserves are not included into the estimates given above.

(iv) Congo

39. Congo, like Cameroon, in the list of oil and gas producing African member States is classified as middle income minor exporter.

40. All exploration and exploitation efforts in the country were concentrated in the Congo basin where the producing formations are of Cretaceous, Paleogene and Neogene age are known. Their total thickness reaches about 7,000m and has some 13 main oil and gas fields belonging to Congo, Zaire and Angola. Over 300 wells were drilled in this Subbasin which produces from lower and middle cretaceous deposits. Total production of crude oil in the basin (i.e. Congo, Zaire and Angola's Cabinda), reached in 1981, 7.3 million tons of oil and negligible quantities of natural gas were produced also. Its reserves were estimated at 200 million tons of oil and 58 billion cu.m. of natural gas as of 1 January 1981.

41. The two largest commercial fields in the country are Emeraude and Loango, which are currently producing at a rate of 60,000 b/d. Recently Likouala field came on stream with initial production close to 30,000 b/d. Two more fields are in the process of development, which proved to be the most significant discoverces in the region these are Sendjo and Yanga.

Offshore oil reserves of the area are estimated at 650 mln bbl in place.

42. Back in 1980 daily crude oil production from the Congo was about 52,000 bbl. In 1984 the Congo produced 6.0 million tons of oil and export figure for 1983 reached 4.8 million tons.

They reported in May 1984 the production peak of 126,000 bbl per day in Congo.

43. Estimated recoverable reserves in Congo by 1984 exceeded 410 MMBBLS and are located almost entirely offshore. It was calculated by Petroconsultants (Geneva) that three-quarters of discovered oil has yet to be extracted and lifespan was put at about 16 years. In the largest oil field Emeraude there is possibility to enhance recoverable reserves provided secondary recovery methods prove to be a success.

44. Gas production in Congo is minor due to a lack of local market for this commodity. At present there are 8 fields proved reserves of which are estimated around 14 billion cubic meters.

45. A 60-mile, 18-in crude oil line run from Loango to Djerro terminal, near Point Indienne. There is only one refinery in Pointe Noire with a capacity of up to 1.2 million tons.

## III EVALUATION OF EXPLORATION EFFORTS AND PETROLEUM POLICY ISSUES

### (a) East Africa

46. This study indicates that Eastern African countries have not been carring out the amount of exploration that would be justified by their geological potential.

47. In a discussion of the petroleum prospects in East African subregion several fundamental geologic issues assume major importance. The first question to be answered by petroleum geologists: has oil or natural gas been generated in the area and are there suitable reservoir rocks ? and the second question to ask is concerning the presence of suitable structures in the subregion. If for the first question the answer is firm and positive the second one may be answered with some reservation as far as sedimentary basins in Eastern Africa are concerned.

48. The exploration efforts in Eastern Africa are far from being adequate to ensure the ultimate discovery of commercial accumulations of oil. In the Red sea basin area which covers 370,000 sq. km., only 27 wells have been drilled so far and in the East African basin comprising 2.0 mln. sq. km. of land and off-shore, 120 exploratory wells only penetrated the thick sequence of sedimentary rocks.

49. The evaluation of Eastern Africa's potential indicated that there is a target for future exploration efforts here. The appraisals given in this paper are derived primarily from regional geological considerations, and, as in any dynamic process, are subject to considerable change with time and application of new geologic data and technique.

50. Lack of finance and trained personnel could be named among a few bottlenecks which plague the development of petroleum resources in Eastern African member States. Studies undertaken by the ECA secretariat have identified several common deterrents to exploration programmes in subregion. These include:

(i) The wrong perception of the geological prospectivity of the subregion based on recent discoveries of exclusively gas-prone areas;

(ii) Inability of the major oil companies to overcome the legislative and contractual constraints which limit access to acreage or the right to export petroleum, or failure to provide adequate financial incentives;

(iii) Unstable economic and political conditions;

(iv) Financial and organizational weakness of the state-owned oil companies even in larger East African countries with a well established petroleum sector.

### (b) Southern Africa

51. In Mozambican basin only 75 wells have been drilled and the surface area of the basin both on land and offshore is about 720,000 sq. km. In this sub-region the problems of petroleum exploration and exploitation vary widely from country to country.

52. Two countries, namely Tanzania and Mozambique, reached the stage of promotion and have achieved some positive results. Two projects have resulted in discoveries, mostly gas, which would justify commercial development and have contributed to renewing the interest of international oil companies in this area.

53. In Angola oil stands out as the exeptional opportunity. For instance in the southern offshore there are still several blocks open for bidding. New acreage has recently been acquired by B.P., Elf and others in a race for position - in what is emerging as a major growth industry.

54. Increasingly, the non-Cabinda produced oil is becoming more significant. However the joint venture of Gulf and Sonangol in Cabinda may quickly raise production level to around 200,000 b/d by the end of the next year. It is expected that by that time Angola should be producing about 365,000 b/d.

(c) Central Africa

55. Congo continues to exhibit a high and non-diminishing reliance on oil as a commercial energy source. Equally this is true in case of the economic development, income and investment expenditures. In 1982 investment expenditure was at a level six times higher than the average of the previous five years, a reflection of greatly increased petroleum exports and increased borrowing under a very ambitious five-year plan. However, since the beginning of 1983, the government has undertaken to make deep cuts in the programme as official reestimates, made in early 1983, showed that oil revenues for the year may be 40 per cent lower than had been originally forecast.

56. Cameroon, situated in-between Africa's two OPEC members, followed an output expansion approach to petroleum production and the country rely heavily on oil exports and revenues.

57. Cameroon, the newest oil exporter in the subregion, continued to grow rapidly, with GDP probably increasing by more than 7 per cent in 1982. Twenty-five years ago Cameroon was a low-income country overwhelmingly dependent on coffee and cocoa as sources of foreign exchange earnings. Now with one of the highest incomes in the region (about US$ 880 per capita in 1981), more diversified exports, and increased credit worthiness, Cameroon has graduated as a borrower from IDA to become eligible for IBRD borrowing.

58. Cameroon's Government percives the medium-term problem as one of the opportunities and perils that accompany large oil exports. The Government has had a measure of success in avoiding the all-too-frequent consequences of a booming oil sector, which produces abundant foreign exchange and fiscal resources: athrophy of other-commodity- producing activities, particularly agriculture, as food imports become easily available and agricultural exports less critical.

59. However the real growth of GDP over 1983-84 was 2-3 per cent and inflation reached 15-20 per cent. There is a strongly growing oil reliance in Cameroon which call for the intensive exploration effort. If previously Cameroon's economy was independent on oil and its economic structure was balanced (unlike in Nigeria), nowadays the picture is gradually shifting and perhaps inexorably.

(d) Petroleum policy issues in Subregions

60. The oil industry analysts say that the organization of Petroleum Exporting Countries (OPEC) have now clearly lost its influence on the world oil market and they predict that the organization is unlikely to regain the former status before 1990.

61. This factor has an important effect on the level of petroleum exploration, exploitation and production in Africa for two main reasons. First, the glut of oil and the restrictions imposed by OPEC on the assumption that the glut will last a long time has discouraged exploration programmes. Second, the relatively depressed state of oil markets has adversely affected oil companies earnings and they have had to trim their costs drastically.

62. The present lull and relative lack of interest in petroleum activity in Africa is unlikely to last long. The majority of short-term forecasts show that demand for oil will rise slowly over next five years 1985-1990 between 1.8 and 2.3 per cent per annum.

63. If this senario is correct, there is little doubt that oil companies will once again, begin to intensify their efforts in Africa. In the meantime, there are a number of things that can be done by African governments to quicken the pace of exploration, exploitation and development of oil fields.

64. In order to reduce dependence on import of oil nonproducing African countries should develop more prospecting and exploration of oil and natural gas for which large scale investment is necessary. Some member States leave the exploration for hydrocarbons to foreign companies or to public national companies. While exploration by private industry tends to be directed towards early economic rewards the nationally owned or parastatal enterprises may accept a long-term comprehensive programme of studies.

65. There is a possibility that exploration efforts in some African countries could result in the discovery of a number of small oil and gas fields over a short period of time. From a commercial stand point it may not be always in the interest of private companies to proceed immediately with the development of these discoveries as they are made. The African governments may have a different view and in appropriate cases should proceed with development of small oil and gas fields for domestic consumption only.

IV. CONCLUSION

66. In the last few years petroleum development in Africa have had to be curbed as part of a scaling down of public expenditure and in order to ensure that balance of payment is not jeoparadized. If the national objectives of highest priority such as energy development are to be realized in member States some of these difficulties will need to be overcome.

67. Since African countries will continue to depend on imported oil for sometime to come it is worthwhile therefore to intensify the search for hydrocarbons. Additionally, conservation measures should be stepped up in order to reduce the foreign currency requirements for oil importation.

68. The medium-term plan have been drafted by the ECA secretariat to expedite the developments in the petroleum sector in East, Southern and Central African member States. According to this plan all possible efforts should be made for increased exploration activities and the development of hydrocarbon resources, natural gas in particular. Efforts in this area should include:

(i) intensification of geological and geophysical exploration in all countries of East, South and Central African subregions;

(ii) evaluation of known hydrocarbon resources and their recoverable portion;

(iii) development and utilization of natural gas resources already identified;

(iv) establishment of the machinery for co-ordination of activities and formulation of policies for national development and utilization of hydrocarbons.

69. The energy future of the countries in East, Southern and Central African subregions will depend to a large extent on their ability to develop their hydrocarbon resources. The programme of co-operation in the field of hydrocarbon development is imperative, which may lead to the identification, selection and realization of the projects of national and subregional interest. This could be the right times for concentrated positive action of the member States in these subregions who can always rely on technical support of the ECA secretariat in the implementation of the national and subregional programmes of hydrocarbon exploration, exploitation and development.